CLAIMS

[0061] What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A pixel cell comprising:

a substrate;

a photosensor in said substrate, said photosensor including a first conductivity area below a surface of said substrate and a second conductivity area at least between said first conductivity area and said substrate surface; and

a first layer having an excess charge sufficient to create an electric field that affects said second conductivity area.

2. The pixel cell of claim 1, wherein said photosensor is a pinned photodiode.

3. The pixel cell of claim 1, further comprising an isolation region spaced from said photosensor, wherein said isolation region has a bottom and sidewalls with said first layer deposited thereon.

4. The pixel cell of claim 3, further comprising a second layer on a surface of said substrate over said isolation region and said photosensor.

5. The pixel cell of claim 4, wherein said second layer has an excess charge sufficient to create an electric field which affects said second conductivity area.

6. The pixel cell of claim 5, wherein said first and second layers comprise a high-k dielectric material.

7. The pixel cell of claim 6, wherein said high-k dielectric material has an excess negative charge.

8. The pixel cell of claim 6, wherein said high-k dielectric material is selected from the group consisting of aluminum oxide, aluminum nitride, and aluminum silicates.

9. The pixel cell of claim 5, wherein said second conductivity area maintains holes at said substrate surface and at a surface of said isolation region sidewall.

10. The pixel cell of claim 5, wherein said field prevents a depletion region of said photodiode from reaching at least one of said STI region and said substrate surface.

11. The pixel cell of claim 6, wherein said high-k dielectric material has an excess positive charge.

12. The pixel cell of claim 11, wherein said second conductivity area maintains electrons at said substrate surface and at a surface of said STI region sidewall.

13. The pixel cell of claim 11, wherein said second conductivity area accumulates electrons.

14. The pixel cell of claim 5, further comprising a dielectric layer between said layer of high-k dielectric material and said substrate.

15. The pixel cell of claim 14, wherein said dielectric layer comprises silicon dioxide.

16. A pixel cell comprising:

a substrate having a first conductivity type;

a pinned photodiode in said substrate and having a charge collection region of a second conductivity type and an accumulation region of said first conductivity type at least over said charge collection region; and

an isolation trench adjacent to said pinned photodiode, wherein sidewalls of said isolation trench have a charge density sufficient to maintain a field in an adjacent portion of said accumulation region and a surface of said substrate has a charge density sufficient to maintain an electric field in an adjacent portion of said accumulation region.

17. The pixel cell of claim 16, wherein said sidewalls and said surface of said substrate each comprise a layer of high-k dielectric material.

18. The pixel cell of claim 17, wherein said first conductivity type is p-type and said second conductivity type is n-type.

19. The pixel cell of claim 18, wherein said charge density is negative charge density.

20. The pixel cell of claim 18, wherein said layers of high-k dielectric material have an excess negative charge.

21. The pixel cell of claim 20, wherein said high-k dielectric material is selected from the group consisting of aluminum oxide, aluminum nitride, and aluminum silicates.

22. The pixel cell of claim 20, wherein said isolation trench is filled with a high-k dielectric material having an excess negative charge.

23. The pixel cell of claim 17, wherein said sidewalls and said surface of said substrate further comprise a layer of dielectric material between said layer of high-k dielectric material and said substrate.

24. The pixel cell of claim 23, wherein said dielectric material is silicon dioxide.

25. The pixel cell of claim 17, wherein said first conductivity type is n-type and said second conductivity type is p-type.

26. The pixel cell of claim 25, wherein said charge density is positive charge density.

27. The pixel cell of claim 25, wherein said layers of high-k dielectric material have an excess positive charge.

28. The pixel cell of claim 25, wherein said isolation trench is filled with a high-k dielectric material having an excess positive charge.

29. The pixel cell of claim 16, further comprising a silicon dioxide layer in contact with said substrate.

30. An imager device comprising:

an image processor; and

a pixel array for supplying signals to said image processor,

at least one pixel of said array comprising:

a substrate;

a photodiode within said substrate;

an isolation trench within said substrate; and

a lining layer in said isolation trench, comprising a layer of high-k dielectric material; and

a surface layer on a surface of said substrate located over said photodiode, comprising a layer of high-k dielectric material.

31. The imager device of claim 30, further comprising a dielectric layer between said isolation trench and said lining layer.

32. The imager device of claim 31, wherein said dielectric layer extends over said surface of said substrate, between said surface layer and said surface of said substrate.

33. The imager device of claim 31, wherein said dielectric layer comprises silicon dioxide.

34. The imager device of claim 30, wherein said lining layer has an excess charge sufficient to maintain a field in a first portion of an accumulation region of said photodiode.

35. The imager device of claim 34, wherein said surface layer has an excess charge sufficient to maintain a field in a second portion of said accumulation region of said

36. The imager device of claim 35, wherein said lining layer and said surface layer are high-k dielectric materials selected from a group consisting of aluminum oxide, aluminum nitride, and aluminum silicates.

37. The imager device of claim 30, further comprising a filling layer located over said lining layer, filling said isolation trench.

38. The imager device of claim 37, wherein said filling layer is selected from a group consisting of silicon dioxide, silicon nitride, oxide-nitride, nitride-oxide, oxide-nitride-oxide, and other insulating material.

39. A pixel cell comprising:

a photodiode in a substrate;

an isolation trench in said substrate and having a bottom and sidewalls adjacent to said photodiode;

a layer of silicon dioxide on said bottom and said sidewalls of said isolation trench; and

a layer of aluminum oxide over said layer of silicon dioxide.

40. The pixel cell of claim 39, further comprising a layer of silicon dioxide on a surface of said substrate over said photodiode.

41. The pixel cell of claim 40, further comprising a layer of aluminum oxide over said layer of silicon dioxide on said substrate surface.

42. The pixel cell of claim 39, wherein said isolation trench is filled with aluminum oxide.

43. A method of forming a pixel cell comprising:

forming an isolation trench in a substrate;

forming at least a first high-k dielectric layer on a surface of said isolation trench;

forming a buried photodiode in said substrate; and

forming a second high-k dielectric layer on a surface of said substrate over said buried photodiode and said isolation trench.

44. The method of claim 43, further comprising the step of forming a silicon dioxide layer over said surface of said isolation trench and said surface of said substrate before forming said first and second high-k dielectric layers.

45. The method of claim 44, further comprising removing said silicon dioxide layer before forming said first and second high-k dielectric lining layers.

46. The method of claim 43, further comprising the step of filling said isolation trench with a dielectric insulating material.

47. The method of claim 43, wherein said first and second high-k dielectric layers are materials selected from the group consisting of aluminum oxide, aluminum nitride, and aluminum silicates.

48. A method of forming a pixel cell comprising:

forming an isolation trench in a substrate;

forming a charge collection region in said substrate;

forming a first accumulation region around said isolation trench, wherein said first accumulation region has an electric field near said isolation trench; and

forming a second accumulation region between said charge collection region and a top surface of said substrate, wherein said second accumulation region has an electric field near said substrate surface.

49. The method of claim 48, wherein the steps of forming said first and second accumulation regions include depositing a silicon oxide layer over sidewalls and a bottom of said isolation trench, and over said substrate surface.

50. The method of claim 48, wherein the step of forming a first accumulation region includes depositing a first high-k dielectric material in said isolation trench.

51. The method of claim 50, wherein the step of forming a second accumulation region includes depositing a second high-k dielectric material over said top surface of said substrate.

52. The method of claim 51, wherein said first and second high-k dielectric materials are selected from the group consisting of aluminum oxide, aluminum nitride, and aluminum silicates.

53. The method of claim 51, wherein said first and second accumulation regions are electron-rich accumulation regions.

54. A method of forming a pixel cell comprising:

forming a trench having a bottom and sidewalls in a substrate having a first conductivity type;

forming a first high-k dielectric layer over said bottom and sidewalls of said trench;

filling said trench with a layer of dielectric material;

forming a charge-collection region having a second conductivity type in said substrate;

forming an accumulation region having said first conductivity type over said charge-collection region and adjacent to said trench in said substrate; and

forming a second high-k dielectric layer above said accumulation region over a top surface of said substrate.

55. The method of claim 54, wherein said first conductivity type is p-type and said second conductivity type is n-type.

56. The method of claim 55, wherein said first high-k dielectric layer is a material inducing hole-accumulation in said accumulation region adjacent to said trench.

57. The method of claim 55, wherein said second high-k dielectric layer is a material inducing hole-accumulation in said accumulation region above said charge-collection region.

58. The method of claim 55, wherein said first and second high-k dielectric layers are materials selected from the group consisting of aluminum oxide, aluminum nitride, and aluminum silicates.

59. The method of claim 54, wherein said first conductivity type is n-type and said second conductivity type is p-type.

60. The method of claim 54, further comprising the step of forming a silicon dioxide layer over said substrate after forming said trench and before forming said first and second high-k layers.

61. The method of claim 60, further comprising the step of removing said silicon dioxide layer before forming said first and second high-k dielectric layers.

62. The method of claim 54, further comprising forming a silicon dioxide layer between said first high-k dielectric layer and said bottom and said sidewalls of said trench.

63. The method of claim 54, further comprising forming a silicon dioxide layer between said second high-k dielectric surface layer and said top surface of said substrate.

64. A method of forming a pixel cell comprising:

forming an isolation trench having a bottom and sidewalls in a p-type substrate;

forming a layer of silicon dioxide on a bottom and sidewalls of said isolation trench;

forming a layer of aluminum oxide on said bottom and said sidewalls of said isolation trench;

forming a photodiode in said substrate adjacent to said isolation trench;

forming a layer of silicon dioxide on a surface of said substrate over said photodiode and said isolation trench; and

forming a layer of aluminum oxide over said substrate surface and said isolation trench.

65. The method of claim 64, further comprising a step of filling said isolation trench with aluminum oxide before said step of forming a layer of silicon dioxide on a surface of said substrate over said photodiode and said isolation trench.

66. The method of claim 64, further comprising steps of removing said silicon dioxide layers before said steps of forming a layer of aluminum oxide.